

that they both arise in the same way, viz. by exposure and subsequent hardening of the secretion peculiar to the gland; for on submitting the smooth oval patch to microscopic examination, I was delighted to find that it covered a collection of glands resembling sweat-glands, each gland being tubular and provided with a distinct duct, but occasionally two ducts would unite near the point where they opened on the patch of smooth skin. As many as fifteen of these ducts can be counted in a single fine section through the patch; therefore the number of the orifices may be estimated at somewhere about seven hundred, and in some cases perhaps as many as a thousand.

On examining the forearm of a fœtal *Lemur catta* I found a cluster of long stiff hairs associated with some large sebaceous glands and at once, though hastily, concluded that this must correspond to those which I have just described. On examining the arm of *Lemur macaco* and *Chirogaleus coquereli* some similar long hairs associated with glands were also detected. On carefully re-examining the arm of *Lemur catta*, it turned out that this peculiar gland is also represented, as seen in fig. 4, which will illustrate its appearance and situation far better than a verbal description.

The tuft of hairs with their glands occurs in all the Lemurs I have been able to examine alive in the Society's gardens and in dried skins in the Prosector's room, as well as in *Hapalemur*. Singularly it is absent in the West-African Lemur, *Perodicticus potto*.

The intention of the paper is two-fold:—1. To call attention to the glands underlying the smooth raised heap of black skin in *Lemur catta*; 2. To draw attention to the tuft of long hairs near it, and its representative in the arm of other Lemurs.

Finally I am of opinion that the spur in *Lemur catta* and the patch of spines in *Hapalemur* are formed of the dried secretions peculiar to the glands.

3. Contributions to the Anatomy of Earthworms.—Nos. I., II., III. By FRANK E. BEDDARD, M.A., F.R.S.E., Prosector to the Society, and Lecturer on Biology at Guy's Hospital.

[Received April 1, 1887.]

(Plate XXXIII.)

- I. On the Structure of *Eudrilus sylvicola*, p. 372.
- II. Further Note on the Reproductive Organs of *Acanthodrilus*, p. 387.
- III. Note on the Genital Setæ of *Perichæta houletii*, p. 389.

I. ON THE STRUCTURE OF *Eudrilus sylvicola*. (Plate XXXIII.)

Mr. W. L. Sclater has kindly presented me with a number of Earthworms which he collected in British Guiana; among these are a few specimens of a species of *Eudrilus* which proves to be new to science. The worms were carefully preserved and have proved to be in an excellent condition for microscopical investigation.



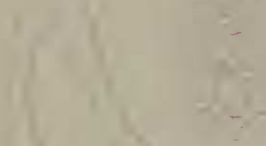
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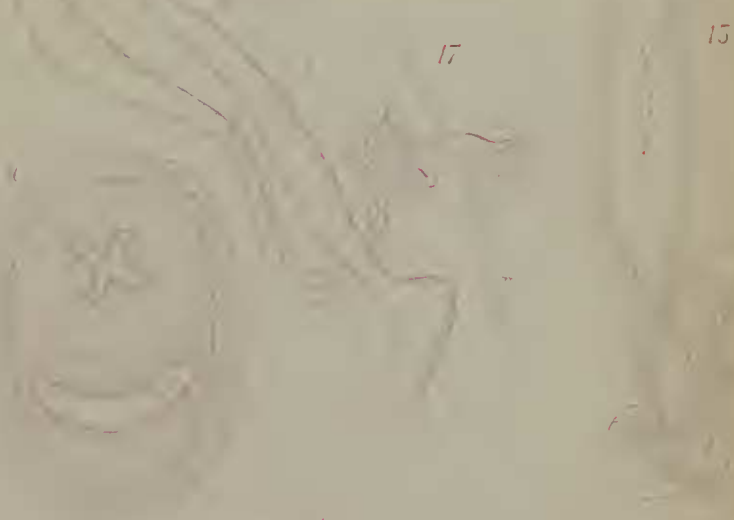


10.



17.

15.



9.



11.



11.



12.





The genus *Eudrilus* was first described by M. Perrier¹, who, however, had only ill-preserved material to work at, consequently his account of the structure of the worm is imperfect; it is very evident, nevertheless, from what he has written upon the subject, that *Eudrilus* is one of the most remarkable genera of Lumbricidæ, and I was particularly glad to have the opportunity of studying its structure in really well-preserved specimens.

The most important facts which I have to bring forward in the present paper concern the structure of the female generative apparatus. In a note communicated to the 'Zoologischer Anzeiger'², I pointed out that Perrier's description of these organs was inaccurate—that it did not, at least, apply to the species (a native of New Caledonia) studied by myself. Perrier was right in stating that the ovary was connected with the spermatheca, and that its contents were set free by passing down the duct of the spermatheca; but he overlooked the fact that the ovary, although apparently sessile upon the duct of the spermatheca, was in reality connected with it by its own duct, a long coiled tube. This latter structure did not indeed escape the attention of Perrier; but he erroneously regarded it as a mere diverticulum of the spermatheca, and failed to make out its connection with the ovary. I was inclined to regard the species of *Eudrilus*³, upon which my own investigations were made, as distinct from any of those which Perrier has described. On this account I held it possible, though not probable, that Perrier and myself were both right, and that the discrepancies between our observations might be explained by supposing a real difference, as regards the points at issue, between the two species. Now that I have been able to study a second species of *Eudrilus*, I am disposed to think that Perrier was entirely wrong in his description.

§ *External Characters.*

The *Eudrilus* which forms the subject of the present paper is a small worm, not measuring more than 32 millim. in length. It is remarkable for the fact that the body is built up of very few segments; I counted 44, 45, and 46 respectively in each of the three specimens at my disposal.

The *colour* of the worm is a dark bluish purple upon the dorsal surface, fading into a dull yellow upon the ventral surface.

The *setæ* are disposed in pairs, as in *Lumbricus*. I did not notice any tendency to an increased number in any of the pairs which Perrier has referred to.

The *clitellum* occupies segments 14–18 inclusive.

The *nephridiopores* are placed in front of the ventral pair of setæ; in all other species of this genus the nephridial apertures are related to the dorsal pair of setæ.

The *female generative pores* are a pair of conspicuous orifices situated upon the 14th segment, and in front of the dorsal pair of setæ.

¹ Nouv. Arch. d. Mus. t. viii. (1872) p. 71.

² No. 224 (1886).

³ Proc. Zool. Soc. May 18th, 1886, p. 302.

The *male generative pores* are related to the ventral pair of setæ, and are situated upon the 17th segment.

In the position of the reproductive apertures the present species agrees with all the other species except *E. decipiens*, where the female pores are upon the 12th segment.

§ *Integument.*

The *epidermis* is covered, as in other Earthworms, by a delicate cuticle; the cells of the epidermis are of two kinds, (1) tall columnar cells, (2) oval glandular cells (Plate XXXIII. fig. 14, *b*): these resemble exactly the epidermic cells of other Earthworms.

In one particular the epidermis of *Eudrilus* differs from *Lumbricus*, and the majority of other genera of Lumbricidæ, and agrees with *Urochæta*, a genus with which it does not show any other marked resemblances. Between the setæ on all the segments of the body is a row of peculiar structures, which appear from the investigations of Vějdovsky to represent degenerate or abortive setæ; they consist in each case (fig. 14, *a*) of a small spherical body darkly stained by borax carmine, which is lodged in an invagination of the cuticle. The cuticle, however, instead of forming a single layer round the central body, is split into a number of layers like the coats of an onion; flattened deeply stained nuclei are situated between these layers. These structures are also found upon the clitellum, and they invariably lie at the base of the epidermis, just above the circular muscular layer.

The structure of the clitellum is precisely similar to that of *Lumbricus*.

The *circular muscle-layer* resembles that of other Earthworms; numerous pigment-granules lie between the individual fibres on the dorsal side of the body.

The *longitudinal muscular coat* shows the bipinnate arrangement of its fibres which Claparède¹ was the first to describe in *Lumbricus*. This fact is worth mentioning, inasmuch as it is unusual in Lumbricidæ; in by far the majority of instances the longitudinal muscle-layer does not show this bipinnate arrangement. I should remark that in the anterior region of the body, *Eudrilus* does not show the characteristic bipinnate disposition of its fibres.

§ *Alimentary System.*

The most interesting feature about the alimentary canal relates to the calciferous glands, which are, in many respects, rather different from those of other Lumbricidæ. The other subdivisions of the alimentary tract are of no special interest, and do not differ materially from those of the more typical genera, such as *Perichæta*. I may state that I have not observed any traces of a *typhlosole*; the absence of this structure, which is generally present in Earthworms, allies *Eudrilus* to *Pontodrilus*. Nor are there in the present species intestinal glands such as those which are characteristic of *Eudrilus*

¹ Zeitschr. f. wiss. Zool. 1869.

*boyeri*¹. The occurrence of such glands, however, is no more remarkable than their absence, and other genera are known (*Acanthodrilus*) in which such glands may be absent or present.

The *calciferous glands* are present to the number of a single pair in segment 12; these glands are lobed, the furrows running parallel with the long axis of the body; they are lateral in position, but extend dorsally above the level of the œsophagus. The structure of these glands is closely similar to that which is found in other Earthworms; they appear to be rather small in size compared to what they are (for example) in *Acanthodrilus*²; in the species of the latter genus investigated by me, the glands nearly fill up the body-cavity of the segments that contain them; they are very far from doing this in *Eudrilus*. M. Perrier makes no mention of the presence of calciferous glands in any of the three species studied by him.

In the tenth and eleventh segments, into which also open the funnels of the vasa deferentia, is a remarkable glandular body; this structure (Plate XXXIII. figs. 5 a, 6) consists of a median unpaired gland lying beneath the œsophagus, and evidently opening into it; in dissecting the worm it was necessary to raise the œsophagus, in order to bring into view these glands, which are completely hidden when the œsophagus is left *in situ*. These glands differ in their general appearance, as well as in their position, from the calciferous glands of the twelfth segment, but do not differ in minute structure. The accompanying figure (fig. 3) illustrates the minute structure of one of these subœsophageal glands; the section has been made through the œsophageal orifice, which is very wide. The lining epithelium of the gland differs in its character from the epithelium of the œsophagus, but there is no abrupt break between the two; the epithelium lining the gland gradually passes into the epithelium of the œsophagus. The epithelial cells of the œsophagus are tall and columnar in form, very narrow at the base, and but slightly wider at the distal extremity; on the other hand, the epithelium of the gland is composed of low cubical cells; the lining membrane of the gland is thrown into a series of folds which anastomose here and there; each fold contains a core of connective tissue in which are blood-vessels. The outer walls of the gland are of course in continuity with the muscular walls of the œsophagus, but their thickness is very considerably less. The serous coat of the œsophagus, as of the alimentary tract generally, is formed by a single layer of tall, pear-shaped peritoneal cells—the so-called “hepatic cells” (fig. 3, *p*); these cells, as in other Earthworms, contain numerous olive-brown, highly refracting particles in their interior. The fact that the base of the cell, where it is in contact with the wall of the alimentary tract, is prolonged into a stalk, which is hyaline and devoid of granules, and which rests directly upon the circular muscular layer, the longitudinal fibres being developed between the bases of the cells, probably gave rise to the erroneous supposition that these cells were glandules opening into the alimentary tract. This serous layer is continued over the

¹ P. Z. S. 1886, p. 302.

² P. Z. S. 1885, p. 811.

subœsophageal gland, but the cells become smaller and more flattened, although they still contain the peculiar yellow granules.

The vascular channels in the walls of the subœsophageal glands appeared to be less developed than in the calciferous glands; I am disposed, however, to think that this was due to accidental causes. As shown in the figure (Plate XXXIII. fig. 3) the contractile "heart" of this segment (*h*) gives off almost immediately after its origin from the dorsal vessel a conspicuous thin-walled vessel (*h'*) on either side, which passes round the œsophagus, and ends upon the surface of the subœsophageal gland; it is doubtless concerned with the blood-supply of the gland.

§ *Vascular System.*

The principal vascular trunks correspond to those of most other intra- and post-clitellian worms; in the œsophageal region there are five longitudinal trunks (I did not observe any lateral vessel), viz. (1) dorsal vessel, (2) supra-intestinal, (3) infra-intestinal, (4) supra-nervian, and (5) subneural. There are five pairs of "hearts" encircling the œsophagus: the first of these lies in segment 8, and connects the dorsal with the supra-nervian vessel; the lateral hearts of segments 10, 11, and 12 are also connected with the supra-intestinal trunk: this did not appear to be the case with the heart of segment 9, although I am not perfectly certain about the point. The walls of the first four pairs of hearts are very muscular and thick; this is not the case with the hearts of segment 12, which are chiefly concerned with the blood-supply of the calciferous glands of this segment.

It is worth pointing out that *Eudrilus* agrees closely with *Thamnodrilus* (see P. Z. S. 1887, pt. i.) in the number of hearts, and in the fact that the three posterior are intestinal hearts, communicating as they do with the supra-intestinal vessel.

The ventral œsophageal glands are supplied (see fig. 3) by a blood-vessel which leaves the supra-intestinal and dorsal trunk; the blood is collected from these glands, and from the walls of the œsophagus generally into the subintestinal vessel.

The supra- and subintestinal vessels are well developed in the region of the œsophagus, being chiefly concerned with the blood-supply of its walls. Each of the vessels (figs. 5, 6, 7) bifurcates in the neighbourhood of the subœsophageal glands.

§ *Nephridia.*

The occurrence of these organs has already been noted by Perrier, who does not, however, give any account of their anatomy.

His division of the Intraclitellians into two groups, which are characterized by the dorsal or ventral position of the nephridiopore, is clearly inadmissible, since the present species agrees with *Titanus* and differs from other species of *Eudrilus* in the fact that the nephridia open by the ventral pair of setæ.

The nephridium itself (fig. 17) consists of a tubule of the ordinary structure and coiled upon itself in a very complicated fashion; the

greater portion forms a tuft situated in the neighbourhood of the ventral pair of setæ (*c*), between these and the nerve-cord; the distal extremity of the tubule opens by the ordinary funnel-shaped aperture (*a*) into the next segment in front.

The excretory tubule then widens out, and forms a section (*b*) which pre-ents a close structural agreement with that lettered (*d*) in my figures of the nephridia of *Thamnodrilus*¹; this opens into the distal section of the organ (*a*) which runs parallel with the last; its walls appear to contain a few muscular fibres. A histological account of the several regions of the nephridium is deferred for the present.

§ Generative Organs.

Female Generative Apparatus.—I have investigated the structure of the female generative organs by dissection as well as by means of transverse and longitudinal sections through the region of the body which they occupy. The excellent state of preservation of the specimens enables me to add some few facts to those which I have already published² concerning the anatomy of the female reproductive organs. I have also been able to observe some facts bearing upon the development of the ovarian ovum, but these I propose to make the subject of a separate paper.

The main facts with respect to the anatomy of the female reproductive organs stated in my former papers, I am able to confirm from the study of the present species. In *E. sylvicola* as in *E. boyeri* (and probably in all other species) the ovary is continuous with a much-coiled duct with ciliated lining epithelium and muscular walls (Plate XXXIII. fig. 12); this opens on to the exterior in common with a large spermatheca, upon the duct of which a small gland is sessile.

A dissection of the present species shows that the female reproductive organs, although opening on to the exterior in the 14th segment, occupy both this and the 13th segment; the mesentery between the two segments is apparently absent. An examination of a series of longitudinal sections shows that the mesentery is not entirely aborted; the large spermatheca lies in both segments, and the mesentery dividing them is attached to the sides of the spermatheca; lower down (see woodcut, fig. 1, p. 381) the mesentery, when present, divides off the ovary, which lies in the 14th segment, from the oviduct, the greater part of which lies in the 13th segment, and from the glandular diverticulum of the spermatheca which lies in the same segment (*sp*, fig. 1). Since the female generative aperture lies in the 14th segment as well as the ovary, it is clear that the oviduct, the greater part of which lies in the 13th segment, must perforate the intersegmental mesentery twice.

It is clear from my sections that the relative positions of the ovary and its duct are precisely the reverse of that which is indicated in

¹ Woodcuts, figs. 5, 6, P. Z. S. 1887 (pp. 160, 161).

² Zool. Anzeiger, Bd. ix. p. 342; P. Z. S. 1886, p. 202; Proc. Roy. Soc. Edinb. no. 122, p. 6.

Perrier's figure (*loc. cit.* pl. ii. fig. 26) ; Perrier places the ovary in the same segment as that which contains the external orifice, and is so far in accord with myself ; but the oviduct is represented as lying behind the ovary instead of in front of it.

In one of the two specimens which I investigated by means of sections, I found a body corresponding exactly in position to the ovary in the majority of Lumbricidæ ; a pair of small cellular bodies exist on the anterior mesentery of segment 13 near to the ventral median line ; these bodies are composed of small indifferent cells, and resemble very closely the testes of the same worm ; each of these is surrounded (Plate XXXIII. fig. 4) by a muscular sac which is continuous with a duct ; the duct appears to open into the duct of the spermatheca opposite to the orifice of the glandular diverticulum ; I succeeded in tracing it forward nearly to this point, but did not observe its actual orifice. The cellular body was attached to the mesenteric wall, and was entirely free from its enveloping muscular sac ; this fact, as well as the evident immaturity of the gland, naturally suggested that the connection with the duct was secondary. There were no traces of cilia in the duct. These glands occupy a position exactly corresponding to that of the testes, *i. e.* just above the ventralmost setæ, while the ovary of segment 14 has a similar relation to the dorsal setæ (see woodcut, fig. 1, p. 381).

It might easily, therefore, be suggested that the structure on the 13th mesentery is the true ovary, and that the supposed ovary in the next segment is really the equivalent of the receptaculum ovarum. The position of the different organs referred to is in accord with such an interpretation ; that is to say, their position so far as concerns the segments which they occupy. The position of the several structures within the segment, however, differs : the glandular body of the 13th segment corresponds exactly with the testes (see below, p. 381, fig. 1) ; a straight line connecting the testes and the glandular body of the 13th segment would run exactly parallel with the long axis of the body ; on the contrary the ovaries of the 14th segment are placed much further away from the ventral median line of the body, and are placed not very far from the female generative pore.

This alteration of position, however, may have been produced during the growth of the ovary and its duct ; and in any case it is a fact which may be used with equal force as an argument either for or against the supposition that the ovaries of segment 14 are ovaries or receptacula. The principal arguments in favour of regarding the ovaries of segment 14 as real ovaries are :—

(1) The fact that the ova undergo their whole course of development in those bodies ; indifferent germinal cells can be traced through all the intermediate stages into fully developed ova. The *receptacula* of other Earthworms, on the contrary, contain only adult or nearly adult ova.

(2) The presence of rudimentary ovaries (?) in segment 13, whose structure and relation to their duct suggests how the continuity between the supposed ovary and its duct of segment 14 may have been

brought about. The adult structure of the supposed ovary of segment 14 might otherwise be regarded as an exaggeration of the partial continuity of the receptaculum ovarum and the oviduct which exists in *Lumbricus* &c.¹

The continuity between the oviduct and the ovary is a fact of some little importance in the comparative morphology of Annelids. In no other form that I am aware of is there a similar connection between the gland and its duct, the two being invariably separate. There is therefore a difference between *Eudrilus* and other Lumbricidæ, like that which exists between *Lepidosteus* and many Teleosteans on the one hand, and *Osmerus* and *Amia* on the other². It may also be remarked that, at any rate in this particular, it is impossible to draw a hard-and-fast line between the Hirudinea and Annelida: hitherto the Hirudinea have been regarded as differing from Annelids in the possession of what have been termed "tubular ovaries," where the duct was supposed to be an outgrowth or continuation of the gland itself. Recently Nussbaum³ has stated that the reproductive organs in certain Hirudinea are developed independently of their ducts, which have a resemblance to nephridia.

It is plain therefore that in this case, at any rate, the distinction between tubular and other ovaries falls to the ground. It is interesting to note that the condition which is characteristic of the Leech may also occur in a Chætopod.

Male Generative Apparatus.—In spite of the fact that Hering⁴ clearly demonstrated the true testes of *Lumbricus*, and distinguished them from the vesiculæ seminales, the latter structures have until very lately been called "testes." The rediscovery by Prof. Bourne⁵ of the testes of the common Earthworm, and a number of subsequent researches, particularly those of Dr. R. S. Bergh⁶, have firmly established the exactness of Hering's statements. With regard to exotic genera of Lumbricidæ, however, our knowledge is still very imperfect. The fact that the so-called "testes" are, in the majority of forms, apparently unconnected with the funnels of the vasa deferentia, and the frequently racemose structure of the former bodies, has probably influenced those writers who have (in my opinion erroneously) described the vesiculæ seminales as "testes." Dr. Horst appears to be the first who has noticed the true testes in any post-clitellian or intra-clitellian Earthworms; in his account of the anatomy of *Perichaeta*

¹ It is quite impossible to regard this body as a receptaculum, containing as it does indifferent cells, unless it be admitted that the receptaculum coincides in position with the ovary, as in the case of the testes and vesiculæ; in this case the continuity of the duct and the sac which envelops the ovary will have to be regarded as secondary. I am quite disposed to regard this as a possible view, but it does not affect the anatomical fact of the continuity of the ovary and its duct in the adult condition.

² "Contributions to Morphology. Ichthyopsida.—No. 2. On the Oviducts of *Osmerus*; with Remarks on the Relations of the Teleostean with the Ganoid Fishes," P. Z. S. 1883, p. 132.

³ Zool. Anzeig. Bd. viii. p. 181.

⁴ Zeitschr. f. wiss. Zool. Bd. viii. (1852).

⁵ Quoted by J. E. Bloomfield, Quart. Journ. Micr. Sci. 1880.

⁶ Zeitschr. f. wiss. Zool. 1886; Zool. Anzeig. 1886, p. 231.

*indica*¹ this naturalist plainly perceived that the structure of the male generative glands in *Perichæta* was essentially similar to that of *Lumbricus*. Mr. Benham² was also able to discover the true testes in *Microchæta*, situated on the anterior wall of the segments which contain them, and enclosed in a common sac with the vesiculæ seminales and the terminal funnels of the vasa deferentia. More recently Dr. Bergh³ has given a full account of the male reproductive organs of *Perichæta*, which establishes without any doubt the correctness of Horst's observations.

In *Eudrilus* there are three pairs of white glandular-looking bodies in segments 10, 11, and 12, which evidently correspond to the structures termed testes by Perrier in his notes on the anatomy of this genus⁴. In the dissected worm these bodies were very friable; and for that reason I have found it impossible to give an accurate idea of their naked-eye appearances. These bodies are not testes, but vesiculæ seminales; their structure resembles that of the vesiculæ seminales of *Lumbricus* (fig. 11, *a*); they consist of a delicate fibrous network of trabeculæ, in the compartments of which are lodged the developing spermatozoa. In the case of the two anterior pairs of vesiculæ seminales, the fibrous sheath of the organ was found to contain (fig. 2, *t*) a small irregularly-shaped body composed of small uniformly-sized cells; these bodies were attached firmly to the ensheathing fibrous tunic, and at one point the fibrous tunic was seen to be continuous with the intersegmental septum close to the nerve-cord; and here the cellular body appeared to be attached also to the mesentery. These two pairs of organs seem to be without doubt the true testes. Their position, attached to the anterior wall of segments 10 and 11, as well as their enclosure by the tunic of the vesiculæ seminales, is entirely in favour of such an identification.

In both the 10th and 11th segments the vesiculæ seminales were united by a median unpaired region, lying beneath the alimentary tract and enclosing the ventral blood-vessel, but not the nerve-cord; it is with this portion of the vesiculæ that the funnels of the vasa deferentia are connected, as will be described shortly. In the case of the anterior pair of vesiculæ this median region was closely packed with bundles of developing spermatozoa; the median region of the 11th segment, on the contrary, was nearly empty of developing spermatozoa.

The two vesiculæ of the 12th segment do not enclose any testis; they appear to be unconnected with the vesiculæ of the two anterior segments; they are in all probability, however, to be regarded as outgrowths of the latter, and not as constituting an independent third pair of vesiculæ.

It is important to notice that *Eudrilus*, although so abnormal in the structure of the female generative apparatus, conforms to the ordinary type in the structure of the male generative organs. The facts detailed above, coupled with the researches of Horst, Benham,

¹ Niederl. Archiv f. Zool. Bd. iv. (1877-78).

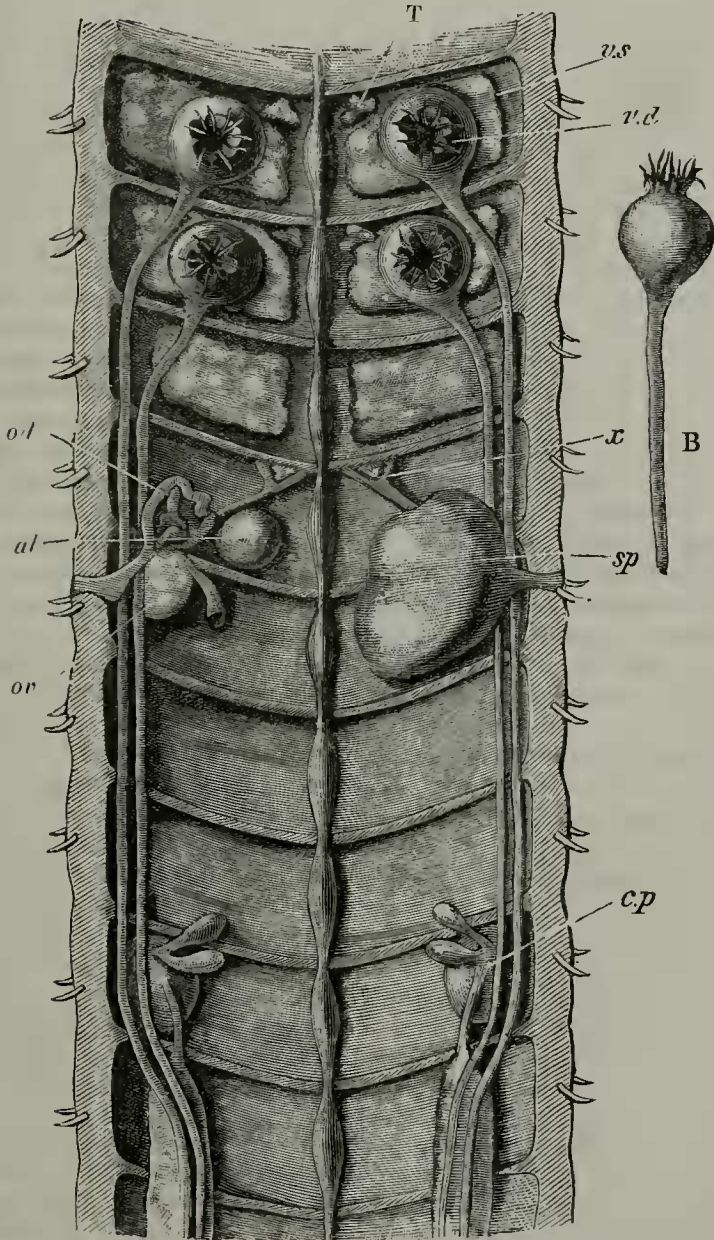
² Quart. Journ. Micr. Sci. vol. xxvi. (new series.)

³ *Loc. cit.*

⁴ *Loc. cit.*

and Bergh, appear to render it extremely probable that in other Lumbricidæ the structures generally described as testes will ultimately prove to be vesiculæ seminales.

Fig. 1.



Dissection of genital region of *Eutrillus sylvicola* (diagrammatic).
 T, testis; *v.s.*, vesicula seminalis; *v.d.*, vas deferens; *x*, rudimentary ovary; *sp.*, spermatheca; *ov.*, ovary; *od.*, oviduct; *al.*, "albuminiparous" gland; *c.p.*, bursa copulatrix; B, funnel of vas deferens, lateral view.

In the present species, as well as in *Eudrilus boyeri*¹, the 10th and 11th segments are occupied by a pair of thin-walled vesicles (woodcut, fig. 1), situated close to each other on either side of the nerve-cord and largely concealed by the superjacent vesiculæ seminales. These vesicles in both species alike were filled with a chalk-white mass, which rendered them far more visible than they would have been if void of contents. In *Eudrilus boyeri* I was unable to ascertain the nature of these structures, and accordingly have not referred to them in my notes on the anatomy of that species. M. Perrier gives no description or figures of any such structures in his species of *Eudrilus*. I was at first inclined to regard these structures as spermathecæ, with which they have not a little resemblance; my sections, however, show that they are really the much-dilated extremities of the vasa deferentia just before they open into the funnel.

Fig. 11 (Plate XXXIII.) illustrates a transverse section through one of these structures, and shows the continuity between the cavity of the vesicle and the terminal funnel. The funnel of the vas deferens is (fig. 11, *c*), as usual, a much plicated membrane, composed of ciliated cells with an underlying layer of muscular fibres, among which are numerous blood-capillaries; the terminal vesicle of the vas deferens (fig. 11, *b*) has exactly the same structure; it is lined by a single row of cubical ciliated cells; in the interior of each of these is a distinct nucleus. Outside the layer of ciliated cells is the muscular coat, composed of fibres running in different directions; the thickness of the muscular coat is not much greater than that of the cellular layer. The anterior pair of vasa deferentia funnels, as shown in the figure (fig. 11), project into the interior of the vesicula seminalis; there is, however, a space left between the masses of spermatophores and the ciliated cells; the whole of the vesicle of the vas deferens, with the exception of the under surface, is completely surrounded by the vesicula seminalis; the delicate fibrous wall of the latter appears to be here in actual contact with the muscular wall of the vesicle; there is, at any rate, no space left between the masses of spermatophores and the wall of the vesicle. The posterior pair of vas-deferens funnels appear at first sight to be completely free from all connection with the vesiculæ seminales of their segment. The vasa deferentia, however, do not open freely into the body-cavity, but into a delicate fibrous sac (which encloses the ventral blood-vessel, and is consequently perforated by the lateral "hearts" of this segment, which unite the ventral with the dorsal vessel). This sac is median and unpaired; it is connected with a short diverticulum on either side, which contains the testis; groups of spermatophores are found in the interior of the sac; and although I have not succeeded in tracing its continuity with the vesiculæ seminales, I have little doubt that the separation is only secondary, if not altogether accidental; it corresponds to the median portion of the vesiculæ in segment 10. The vasa deferentia remain separate for the whole of their course; the two vasa deferentia of each side only become united within the tunic* of the prostate gland. They are furnished with an unusually

¹ P. Z. S. 1886, p. 302.

well-developed muscular coat (fig. 11, *b*); the lining epithelium is ciliated throughout.

The terminal apparatus of the male generative system in *Eudrilus* is extremely unlike what is found in other Earthworms. It has been already partly described by Perrier and by myself; but these descriptions refer only to the rough anatomy of the organs, and not to the minute structure. With regard to one point there is some discrepancy between Perrier's account and my own, and that is the termination of the vasa deferentia. These tubes, as already stated, are remarkable for the fact that they possess a thick muscular coat, which is wanting in the vasa deferentia of other Earthworms; the two vasa deferentia, instead of uniting to form a single tube, as they do in the majority of Lumbricidæ (in all except *Acanthodrilus*), remain distinct and open separately into the terminal region of the prostate gland. M. Perrier has figured (*l. c.* pl. ii. fig. 26, *a*) a single vas deferens opening into the muscular sac of the penis in *Eudrilus decipiens*; and there are no statements in his paper which would lead to the inference that in the two other species there was a difference in respect of these organs. Towards their distal extremity the vasa deferentia increase notably in diameter (*cf.* figs. 1, 16).

In *Eudrilus boyeri* I found the important difference in the vasa deferentia and in their relation to the terminal apparatus that has been just referred to, and which is fully described and figured in my paper upon that species; and I am now in a position to state that in *Eudrilus sylvicola* the arrangement of these organs is precisely similar. This fact renders it probable, in my opinion, that the structure of the terminal apparatus of the male sexual organs in *Eudrilus* generally is closely similar to that of *E. sylvicola*, which is now to be described in detail.

On opening the body of the worm the conspicuous prostate glands are to be seen, which extend back from their opening into the bursa copulatrix of the 17th segment for some way. M. Perrier rightly points out the nacreous appearance of this organ, which only resembles the prostate gland of other Lumbricidæ by its position:—"mais qui ne présente en aucune façon l'aspect glandulaire de ces dernières." An investigation of the structure of this sausage-shaped body shows very plainly that it is of a glandular nature and that it resembles in many points the prostate glands of other Earthworms. The glandular nature of the organ is, however, masked by the very great development of its muscular layers, which give to it the peculiar nacreous appearance which is so characteristic. A study of the organ by means of transverse sections (see Plate XXXIII., fig. 13) shows that these muscular layers together form a coat of very considerable thickness; by far the greater part is occupied by the longitudinal fibres, the transverse fibres forming a very delicate layer within these. The glandular tissue of the organ is divided into two layers, which agree very closely in structure with the prostate glands of *Acanthodrilus*, and also present an unmistakable resemblance to the epidermis of the clitellum. The inner row of cells which surround the lumen of the gland are narrow, elon-

gated, highly granular cells; the rest of the epithelium of the gland is composed of glandular cells, rounded and swollen at the base and terminating in a fine slender duct; there are numerous rows of these cells. The lumen of the gland for the posterior half is triangular (Plate XXXIII. fig. 8); further forward (fig. 9) it becomes cross-shaped. In the posterior half of the prostate, however, the gland is divided into two tubes, which are quite independent of each other: rather behind the point at which the vasa deferentia perforate the coats of the prostate the inner circular muscular layer of the gland is deflected inwards (see fig. 10), and cuts up the interior into two parallel chambers; the one contains the continuation of the lumen of the prostate which has just been described, while the other contains at first merely a mass of glandular cells cut off from the outer layers of glandular epithelium by the invasion of the circular muscular layer. Presently a lumen is developed in this part of the gland, which has a crescentic outline; there is absolutely no continuity at this end between the two tubes; the lining epithelium of the second tube ultimately comes to resemble in every particular that of the principal tube; there is no external indication of the division of the prostate into two parallel tubes; the section of the whole organ is an unbroken ellipse. Where the vasa deferentia perforate the walls of the prostate the second tube is already established; the vasa deferentia make their way separately through the muscular coats of the gland, losing their own special muscles: the vasa deferentia become very fine tubes, which are not easy to recognize; they appear to become united in the circular muscular coat of the prostate into a single tube which passes along the muscles dividing up the interior of the prostate; the vas deferens then becomes continuous with the prostate gland, but with the original portion of the gland, and not with the second tube. Theoretically one might suppose that each vas deferens opened into a separate part of the prostate, and that the division of the latter corresponded to the separation of the vasa deferentia; I cannot, however, find any evidence that this is the case.

Each of the two portions of the prostate becomes continuous with a narrow tube that leads to the penis (see fig. 15); in correspondence with the difference in size between the two portions of the prostate, the outermost of the two tubes leading to the penis is smaller than the inner. A little before they enter the penis the two tubes join into a single tube.

The *penis* (*p*, Plate XXXIII. fig. 15) is a muscular process of the walls of the bursa copulatrix; it contains a median canal, which is continuous with the lumen of the duct of the prostate gland. The internal canal of the penis, however, does not alone communicate with the vas deferens; towards the base of the organ, *i. e.* towards its base of attachment to the walls of the bursa, it bears a longitudinal groove, which shortly becomes closed in and forms a canal, ultimately opening into the canal of the penis; there is therefore an open communication between the vas deferens and the interior of the bursa copulatrix; in fact, in the specimen which I studied by means of transverse sections, a mass of spermatozoa partly filled up the canal

leading from the internal lumen of the penis to the exterior of the organ. These points are illustrated in the diagrammatic drawing of these parts (fig. 15).

Next to the extraordinary complicated structure of the terminal section of the male generative ducts, the most remarkable fact about these organs in *Eudrilus* is the muscular coat of the vas deferens. In so far as I am aware, there is no Earthworm in which these tubes consist of more than a ciliated cubical epithelium surrounded by a delicate peritoneal investment; the muscular coat of the vas deferens is another point of resemblance to the Leech.

Besides the "prostate" gland, the copulatory apparatus is furnished with another structure—the Y-shaped appendage of Perrier. This body has been correctly stated by Perrier to open into the bursa copulatrix, although his dissections did not enable him to demonstrate its precise relations. In my paper on the anatomy of *Eudrilus boyeri* I stated that the duct of the Y-shaped gland opened into a cushion-like outgrowth of the bursa copulatrix, which Perrier has figured (*l. c.* pl. ii. fig. 27). I find that in the present species the structure is the same. The body in question in *E. sylvicola* appears to be invariably Y-shaped (fig. 15); the two arms of the Y never join at their extremities to form a horseshoe-shaped tube, as is stated by Perrier to occur in his species and by myself in *E. boyeri*. The two arms of the Y remain separate for only a short distance, when they become united into a single tube, which passes through the pad-like outgrowth of the walls of the bursa, and opens at its extremity into the interior of the bursa. The structure of the Y-shaped body is illustrated in Plate XXXIII. fig. 15; its walls are very thick and muscular, and the narrow lumen is lined by a somewhat flattened epithelium; the extreme development of the muscular layers as compared with the epithelial lining rather suggests that its function is not that of a gland. Although the duct of the Y-shaped appendage opens freely into the interior of the bursa, it is really practically continuous with the lumen of the penis; the pad which bears the terminal orifice of the Y-shaped appendage projects so far into the interior of the bursa as nearly to occlude its lumen; only a narrow space is left between the pad and the penis, and this communicates directly with the lumen of the penis by the orifice already referred to above under the description of the penis.

The pad itself is very muscular, and it is easy to imagine that by appropriate contraction of its walls the duct of the Y-shaped appendage might be brought into actual continuity with the interior of the penis. I have no facts at my disposal which enable me to state positively what is the function of the Y-shaped appendage, but I am rather disposed to think from its structure and relations that it serves as a seminal reservoir.

There is no doubt that *Eudrilus* differs very widely from other Lumbricidæ in the structure of the female generative apparatus, and in the terminal apparatus of the male generative organs. In spite, however, of this great divergence, it agrees very closely in other particulars with the ordinary type of structure which characterizes the

Lumbricidæ; the testes and vesiculæ seminales conform in every respect to *Lumbricus* or *Perichæta*; the position of the gizzard, the presence of calciferous glands on the posterior region of the œsophagus, the extent of the clitellum and the relations to it of the male generative apertures, all point to the resemblance of this genus to many Intraclitellian forms. The presence of the peculiar epidermic structures believed by Vějdovsky to represent abortive setæ, ally *Eudrilus* to *Urochæta* in particular among the Intraclitellians. The origin of the lateral "hearts" from the dorsal vessel, and not from a supra-intestinal trunk, is a point in which *Eudrilus* as distinctly assimilates to many Postclitellians and Intraclitellian worms.

The muscular penis of *Eudrilus* is, however, in my opinion, not to be regarded as a new structure; in many species of *Perichæta* the terminal portion of the vas deferens is a thick-walled muscular tube which can be everted, and which doubtless serves as a copulatory organ; from this condition to that which is characteristic of *Eudrilus* is not a wide step, the everted condition of the terminal section of the vas deferens being permanent in the latter genus. Another point of difference from the remaining Lumbricidæ is in the number of accessory organs which open in common with the vasa deferentia; it must be remembered, however, that the vasa deferentia retain their distinctness up to their point of opening on to the exterior, and the presence of *two* prostate glands is therefore not surprising. It is also possible that there is a similarity in this respect between *Eudrilus* and *Perichæta ceylonica*¹, only that in *Eudrilus* all the accessory male glands are concentrated, and come to open on one segment in common with the sperm-ducts.

The female generative apparatus, however, appears to be absolutely unique; there has been nothing like it described in any other Earthworm. So far as our present knowledge goes, it seems necessary to separate *Eudrilus* into a distinct family. Perrier himself has shown reasons for believing that different species of the genus may have the male generative openings either within or behind the clitellum, and in any case *Eudrilus* shows no marked affinities to any Postclitellian or Intraclitellian genera. I am unwilling, however, at present to regard *Eudrilus* as the type of a new family equivalent to either Postclitellians or Intraclitellians, and I think that Vějdovsky's plan of dividing the Oligochæta terricola into several families (*Perichætidæ*, *Urochætidæ*, &c.) is most in harmony with our present knowledge of the structure of the group.

The present species cannot be identical either with any of those described by M. Perrier, or with a fourth species recently described by myself, from New Caledonia.

It differs in the position of the nephridiopores, which open in front of the ventral pair of setæ, and not by the dorsal pair as in all the other species of the genus at present known.

If M. Perrier had not, in his description of the genus, particularly stated that the nephridiopores are developed in relation to the dorsal setæ, I should have referred this species to *E. peregrinus*.

¹ Ann. & Mag. Nat. Hist. 1886, xvii. p. 89.

Like *E. peregrinus*, the present species is a native of the continent of South America; in both the clitellum occupies segments 14–18 inclusive. M. Perrier describes in the 10th segment, “une sorte de toute petite masse glandulaire, absolument indéterminable,” which may possibly be one of the median ventral œsophageal glands already described (p. 375).

II. FURTHER NOTE ON THE REPRODUCTIVE ORGANS OF *Acanthodrilus*.

In the ‘Proceedings’ of this Society for 1885 I published an account of the anatomy of three species of the genus *Acanthodrilus*. On reexamining my preparations, I find that I have misinterpreted the nature of certain structures described in that paper. At the time that I wrote, hardly anything was known of the structure of the male reproductive organs in exotic Lumbricidæ; the only paper on the subject, however, appeared to show that in *Perichæta* at any rate¹ the so-called testes of Perrier and other writers were really the equivalents of the seminal vesicles of *Lumbricus*, and that the testes of the latter were represented by homologous structures. Since then Mr. Benham² and Prof. Bergh³ have brought forward conclusive evidence that the structure of the male generative organs in *Microchæta* and *Perichæta* is essentially similar to those of *Lumbricus*. In both genera there are two pairs of testes, which become enveloped by the seminal vesicles. My own investigations into the structure of *Eudrilus (antea, p. 380)*, and a genus to be described in a future paper, lead me to confirm in every point the justice of the conclusions arrived at by Benham and Bergh. In the light of these researches I have again examined the structure of the male reproductive organs in *Acanthodrilus dissimilis*, and have to make the following additions to and corrections of my former paper.

In the woodcut which illustrates that paper I have figured two pairs of glands, situated in the 11th and 12th segments respectively, and attached to the anterior mesenteries of these segments and to the vasa deferentia at the point where they perforate the mesenteries (fig. 3). I find that I have omitted both in the figure and in the description (p. 824) which accompanies it another pair of glands, which are situated on the anterior mesentery of segment 10; the accompanying drawing (fig. 2, p. 388), which is an alteration of the original woodcut, illustrates this point. The three pairs of glands are closely similar in structure to each other and to the ovaries, which occupy a similar position in segment 13. In my paper already referred to, I noted the fact that the glands which are situated in segment 12 not only agree in structure with the ovaries, but that in one specimen at any rate they contained fully developed ova. This fact (which I have since verified by a renewed examination of the specimens) led me to infer that the glands, both of this segment and of the one in front, were a rudimentary pair of ovaries which perhaps never reached maturity. In the light of recent researches—I refer to those of

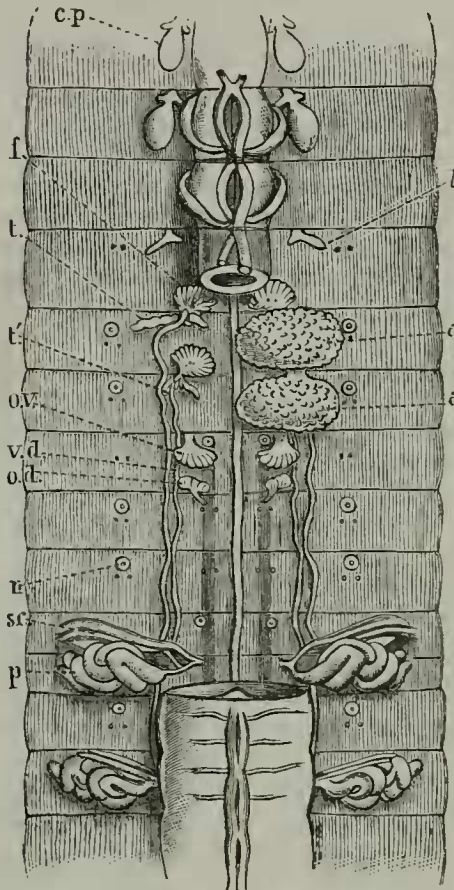
¹ R. Horst, Niederl. Archiv f. Zool. *loc. cit.*

² Quart. Journ. Micr. Sci. 1886.

³ Zeitschr. f. wiss. Zool. 1886.

Benham and Bergh—I am now convinced that the pair of glands in segment 11 represent the posterior pair of testes in *Lumbricus*, and that the glands in segment 10, which I record for the first time in the present communication, represent the anterior pair of testes in *Lumbricus*; it follows, therefore, that the “testes” of my former paper are the vesiculæ seminales. The glands of segment 12 now remain to be accounted for; it seems to me that the clue to the nature of these glands is to be found in Dr. Bergh’s paper already referred to. Dr. Bergh describes and figures in *Lumbricus* a pair of

Fig. 2.



Acanthodrilus dissimilis. Dissection of genital region; the œsophagus has been partially removed; the vesiculæ seminales have been entirely removed from segment 10 and from the left side of segments 11, 12.

sp, spermatheca; *a*, vesiculæ seminales; *t*, testes; *t'*, additional pair of ovaries; *ov*, ovaries; *od*, oviduct; *f*, vas deferens funnel; *v.d.*, vas deferens; *n*, nephridial aperture; *p*, prostate; *sc*, sac containing penial setæ.

rudimentary structures in segment 12, which he regards as an anterior pair of ovaries which do not arrive in that genus at sexual ma-

turity. The fact that in *Acanthodrilus* those glands do produce ova is, to my mind, a very strong confirmation of the correctness of Dr. Bergh's interpretation. I would also recall to the recollection of those interested in the group, the fact that *Perionyx excavatus* possesses occasionally two pairs of fully developed ovaries¹. The correspondence between the male and female glands in Lumbricidæ is thus closer than was at one time thought; there are two pairs of testes and two pairs of ovaries, although as a general rule only one pair of ovaries arrives at sexual maturity. The occasional presence in *Perionyx* of two pairs of oviducts, if it is to be regarded as a reversion, is a further point of similarity.

It is generally believed that the Oligochæta are to be derived from ancestors resembling in certain points existing Polychæta. One of the essential points of difference between the two groups, so far as we at present know them, is the limitation of the reproductive glands in Oligochæta; in the Polychæta there is an indefinite number of reproductive glands, and most of the segments contain ovaries or testes; in the Oligochæta terricola, on the contrary, the testes are limited to two pairs² and the ovaries to a single pair; the occasional presence of rudimentary or fully developed ovaries in the 12th segment is evidently an intermediate step in the reduction of the generative glands.

III. NOTE ON THE GENITAL SETÆ OF *Perichæta houletti*.

I have lately received, through the kindness of my friend Mr. W. F. R. Weldon, a large number of Earthworms collected by him during a recent visit to the Bahamas. The collection includes a species of *Eudrilus*, probably identical with one of the species described by Perrier from this quarter of the globe, and two species of *Perichæta*. The *Perichætæ* are referable to two distinct species, both of which have already been described, but have not, so far as I am aware, been recorded from the New World. One of these is *Perichæta affinis*, a species at present only known from India, China, and Luzon; it is interesting, therefore, to notice the occurrence of the same species in the West Indies. The other is *Perichæta houletti*, recorded by Perrier from Calcutta and Cochin China, and by myself also from the former locality. The structure of this species has been described in some detail by Perrier³, but his memoir contains no account of the peculiar modification which the setæ upon the clitellar segments undergo.

The specimens at my disposal were not in a fit condition for section-cutting, owing to an accident during their transit; but this was the less to be regretted, as the softened integument allowed the cuticle to be readily stripped off, and the setæ from different parts of the body to be examined; this usually cannot be done in well hardened examples.

The setæ, which are, of course, disposed in a continuous ring

¹ P. Z. S. 1886, p. 308.

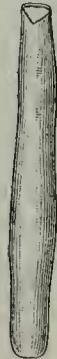
² In the Limicolæ the testes may be much more numerous.

³ Nouv. Arch. d. Mus. t. viii. (1872).

round the middle of the body, as in other *Perichætæ*, are much like those of other species on the hinder part of the body, that lying posterior to the clitellum; the setæ of the anterior segments of the body agree very closely in their shape with these, but are very much larger. On the clitellum, however, the setæ are very different in appearance; they are (woodcut, fig. 3) of very small size compared to the setæ of the anterior preclitellar segments, and terminate in a distinctly bifid extremity; the two points in which the seta ends diverge at a considerable angle from each other, but are connected by a delicate membrane. The opposite extremity of the seta, which is imbedded in the body-wall, is abruptly truncated. The whole seta has not the S-shaped curve which is so constant a character in the group, but is curved only in one direction. As in the other setæ of the same species, and in the setæ of Earth-worms generally, the middle part is somewhat thicker; but this region does not lie in the middle of the setæ but is closely approximated to the posterior extremity; the part of the seta which lies behind the dilated region is straight. The general shape of these clitellar setæ, apart, of course, from the bifid extremity, is like that of imperfectly developed ordinary setæ. That this is not really the case with these setæ is, however, clearly shown by the fact that all the setæ of the several rows comprised in the clitellum have precisely the same shape, and also by the fact that in two specimens of the worm, which were the first that came to hand, the structure of these clitellar setæ was precisely identical.

This is, I believe, the first record of any such modification of the

Fig. 3.



Clitellar seta of *Perichæta houlleti*.

clitellar setæ in the genus *Perichæta*. In *P. affinis* I have been able to satisfy myself that the clitellar setæ differ in no respect from the setæ of the general body-surface; in *P. indica* setæ appear to be altogether wanting upon the segments of the clitellum. There are, however, other species of Lumbricidæ in which there is a perfectly analogous modification of the setæ; in *Lumbricus* the clitellar setæ are distinguished from those upon the other segments of the